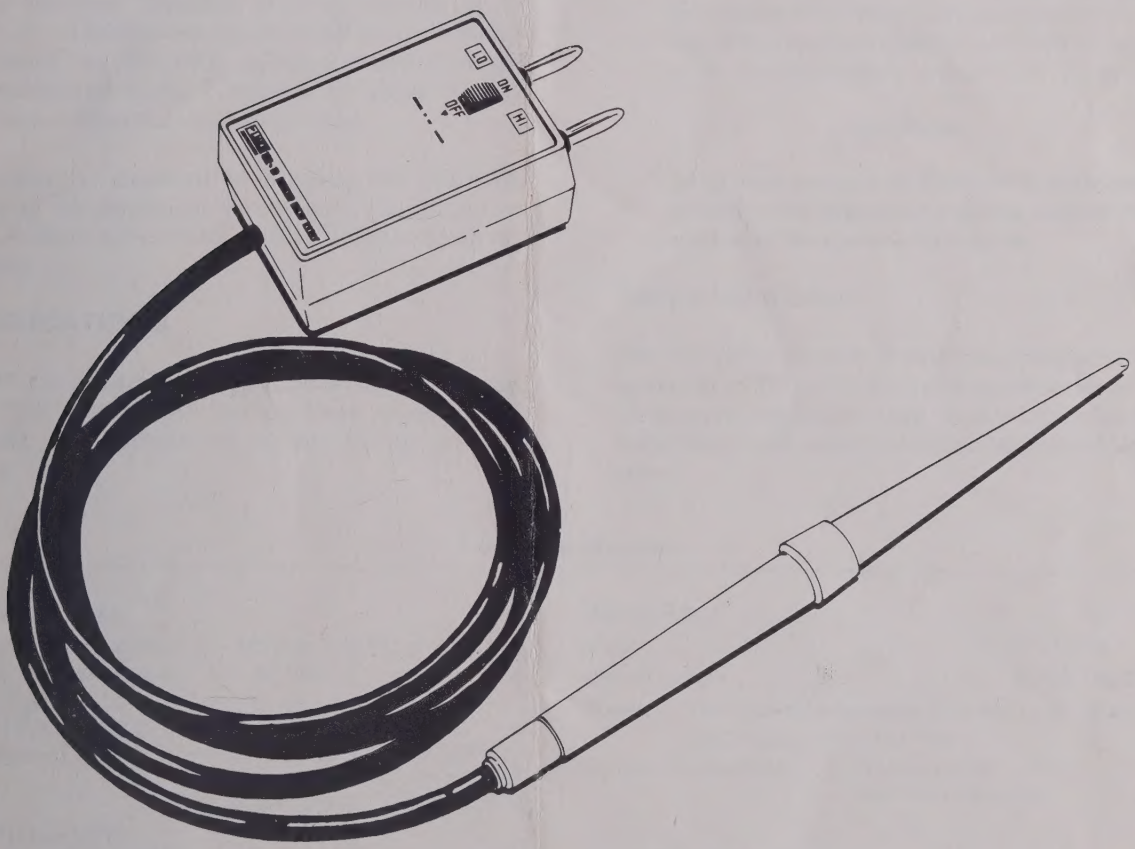
FLUKE®

Instruction Manual

Model 80T-150

Temperature Probe



INTRODUCTION

The Model 80T-150 Temperature Probe is a self-contained temperature-to-voltage converter. It is designed to provide a direct temperature reading when connected to any high impedance voltmeter that is capable of 1 mV resolution, and at least a 300 count full-scale readout capability. Two temperature ranges are provided, and either can be jumper selected; -58 to +302°F or -50 to +150°C.

The unit is housed in two separate assemblies; a temperature probe and a temperature-to-voltage converter. The probe contains the temperature sensing element and is electrically connected to the temperature-to-voltage converter through a 46-inch shielded cable. Two banana plugs with standard 0.75 inch spacing are provided for connecting the 80T-150 to the voltmeter.

Operating power for the 80T-150 is derived from two internal batteries. Typically, they will provide up to 1000 hours of continuous operation before replacement is necessary. An ON/OFF switch is provided on the temperature-to-voltage converter to allow battery conservation when the unit is not in use.

Temperature is measured by exposing the probe tip directly to the material to be measured (liquid, gas or solid). A direct temperature reading is displayed on the voltmeter.

SPECIFICATIONS

The 80T-150 will achieve rated accuracy when used with any 0.25% DVM which has an input impedance of $\geq$ 1 MΩ. Specifications for the 80T-150 are given in Table 1.

OPERATING NOTES

The following paragraphs are intended to familiarize the operator with the 80T-150, as shown in Figure 1. They should be read before attempting to operate the probe.

Probe Limitations

The 80T-150 probe is constructed of a highly durable plastic and is suitable for measuring the temperature of liquids, gases and solid surfaces up to 150°C. When measuring temperature, observe the following precautions to prevent damage to the probe:

a. Do not expose the probe end (probe tip plus ≈2 inches of probe body) to temperatures in excess of +150°C. The remainder of the probe body should not be exposed to temperatures above +70°C.

b. For liquid measurements, recommended applications range from water, lubricants and fuels to most solvents. Liquids as shallow as ½" can be measured since the temperature sensor is in the probe tip.

CAUTION

Long term exposure of the probe to corrosive environments will result in pitting and deterioration of the aluminum probe tip.

Temperature Scale

The 80T-150 is capable of providing temperature measurements in °C or °F. See decal opposite power switch for assigned temperature scale. Instructions for changing temperature scale are given later under General Maintenance.

Table 1. Specifications

ELECTRICAL

Range (field selectable by internal jumpers)	−50°C to +150°C or −58°F to +302°F
Accuracy +15°C to +35°C ambient	±1°C (1.8°F) 0°C to 100°C, decreasing linearly to ± 3°C (5.4°F) at −50°C and +150°C
0°C to +15°C and +35°C to +50° ambient	Add 1°C (1.8°F) to above
Sensitivity (80T−150 output)	1 mV dc/°C or 1 mV dc/°F
Voltage Standoff	350V dc or peak ac
Settling Time	5.5 seconds to settle within 2° for a 50° change.

GENERAL

Weight	100 gm (3.5 oz.)
Overall Length	1.33 meters (52.5 in.)
Power	Two internal disposable batteries (1.5V, Size "N") 1000 hours continuous use
Output Termination	Standard 0.75" spaced double banana plug

ENVIRONMENTAL

	Entire Unit	
	Storage	Operating
Altitude	≤50000 ft.	≤10000 ft.
Temperature	−40 to +70°C	0 to +50°C
Humidity	—	80% non-condensing

Application Force . . . . . 20 pounds max.
(Probe tip-to-measurements surface)

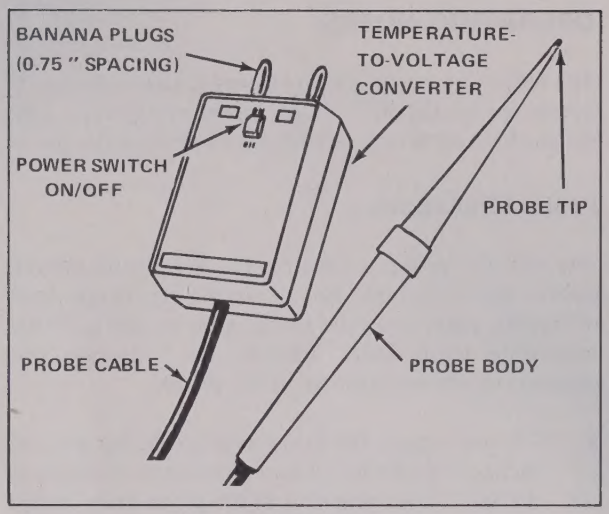


Figure 1. 80T-150 Features

Error Sources

When the probe tip is applied to a solid surface it draws or sinks heat from the surface. Therefore, if the measured surface has a low mass (e.g., a transistor case), the indicated temperature may be lower than the actual temperature.

Similarly, a steady-state error or gradient exists between the measured surface and the sensing device in the probe tip. This is due to the flow of heat from the measurement surface to the probe body. The effect of the steady-state error increases as the differential between ambient and surface temperature increases.

To determine the actual surface temperature of a device, both the heat-sinking and steady-state errors must be considered. The correction curve given in Figure 2 approximates the effect of both error sources on TO-3, TO-5 and TO-18 transistor cases.

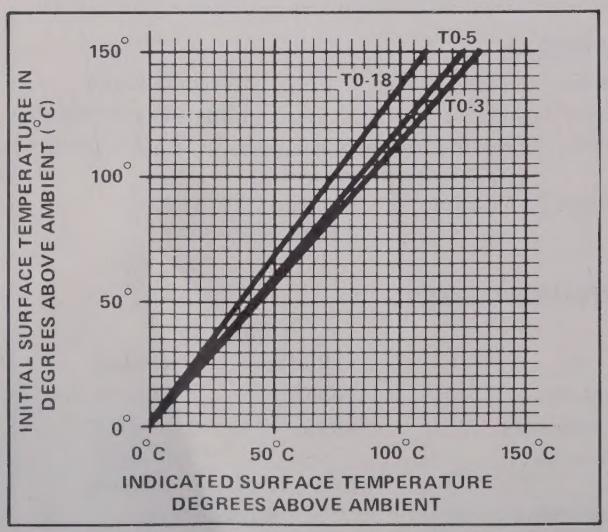


Figure 2. Initial Case Temperature Above Ambient vs. Meter Reading Above Ambient

RF signals applied to the 80T-150 probe tip can also cause errors in temperature measurement. Figure 3 defines the rf signal limits that can be tolerated without degrading measurement accuracy.

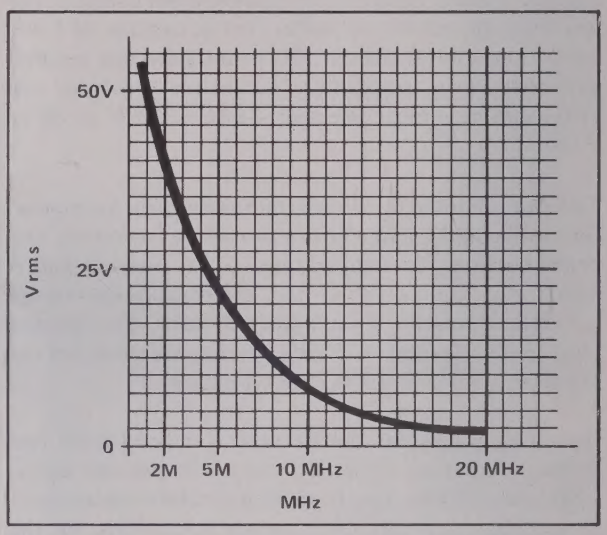


Figure 3. Maximum Signal RF Limits (Vrms) at Probe Tip

OPERATION

Use the following procedure to operate the 80T-150 probe:

a. Connect the banana plugs on the 80T-150 to the input terminals of a high impedance voltmeter. Observe polarity.

b. Select a dc voltage range that will provide at least 1 mV resolution (1 mV/degree), and a full scale readout that will encompass the expected temperature. The 2V range of a 3½ digit DVM is adequate. Ignore readings of less than 1° when a more sensitive DVM is used.

c. Set the 80T-150 power switch to ON and energize the voltmeter.

d. Firmly touch the probe tip to the surface to be measured, or expose it to a liquid or gas. The voltmeter will display the temperature in degrees. Vary probe angle and pressure when measuring solid surface temperatures; the highest stabilized reading will be the most accurate.

CAUTION

The force exerted on the probe tip should not exceed 20 pounds.

THEORY OF OPERATION

The Model 80T-150 utilizes the negative temperature coefficient of a semiconductor (P-N) junction to measure temperature. The PN junction is thermally integrated

into the probe tip and comprises one leg of a bridge circuit as shown in simplified circuit diagram section of Figure 4. Two 1.5V batteries are used to power both the bridge circuit and operational amplifier U2. Since the bridge must be balanced to provide 0°C and 0°F indications, separate range or temperature scale resistors RA and RB are included in the bridge circuit. When RB is shorted, the °C scale is selected and the bridge is calibrated by R2 to null at 0°C. Conversely, when RB is open, the 0°F scale is selected and the bridge is calibrated by R2 to null at 0°F. Deviations above and below 0° provide a bridge output of approximately 2.45 mV/°C.

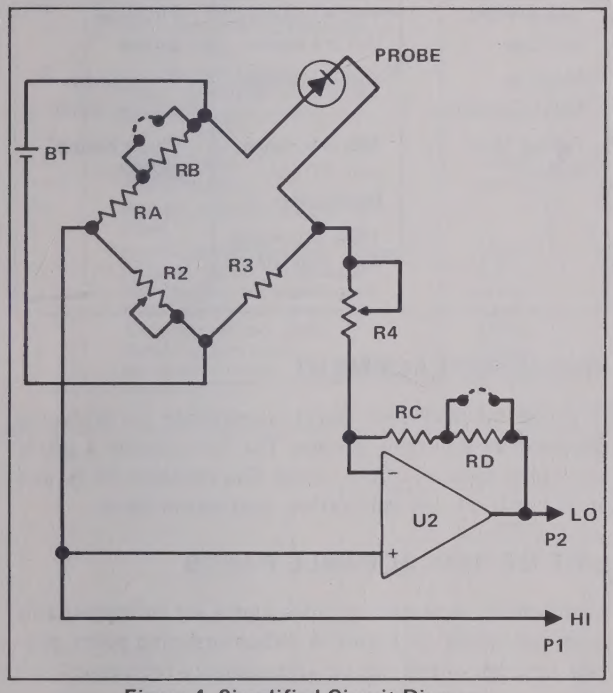


Figure 4. Simplified Circuit Diagram

Operational amplifier U2 is used to measure the bridge output and scale it to a 1 mV/degree signal. Since the °C and the °F scale are sloped differently, the scale for U2 must be matched with the scale selected for the bridge circuit. Shorting resistor RD selects the °C scale. Conversely, when RD is open the °F scale is selected. Resistor R4 calibrates both scales.

The output voltage used to drive the external voltmeter is taken from the output of U2 (P2) and the reference side of the bridge (P1). Since U2 is operating as an inverting amplifier, its output is used as the low input to the voltmeter. This enables the voltmeter to display an increase in temperature as an increase in voltage.

GENERAL MAINTENANCE

Access Information

The battery, the temperature scale jumpers and the calibration pots are located on the interior of the temperature-to-voltage converter assembly. Access to these locations is accomplished by removing the three screws from the bottom side of the assembly and removing the plastic box.

Battery Replacement

The 80T-150 uses two 1.5 volt, size N, alkaline batteries. They provide a useful operating life of ≈1000 hours. To replace the batteries pull the old ones out and press the new ones into the battery holders. Match polarity marked on the pcb. Mercury or equivalent N-size batteries may be installed in the 80T-150.

Temperature Scale Jumpers, °C or °F

The jumper locations for selecting either the °C or °F temperature scale are shown in Figure 5. The absence of jumpers at both points indicates selection of the °F scale. The presence of solder bridges at both points indicates selection of the °C scale. Under no circumstances should one point be open while the other is bridged.

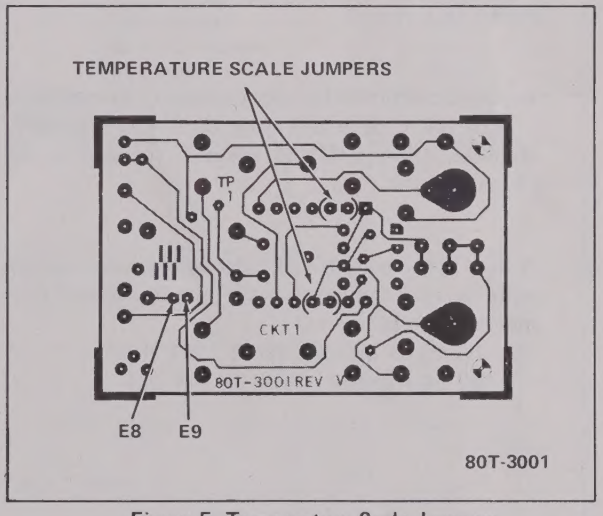


Figure 5. Temperature Scale Jumpers

PERFORMANCE TEST

Complete the calibration procedure without opening the temperature-to-voltage converter assembly and without making any calibration adjustments. Observe the readings given in [brackets]. Other readings are for calibration only.

CALIBRATION

A calibration cycle of 1 year is recommended to maintain the unit within the specifications given earlier. The equipment required for calibration is listed in Table 2.

NOTE

Values given in brackets apply to the Performance Test.

a. Access the interior of the temperature-to-voltage converter.

b. Determine the selected temperature (°C or °F). See marking on bottom cover decal.

c. Connect the 80T-150 to a DVM and select the 100 mV dc range (10 μV resolution).

d. Turn the 80T-150 power switch to ON and immerse the probe tip ≈2 inches into a thermometer monitored 0°C bath. Allow the DVM reading to stabilize (≈30 seconds).

e. Adjust R2 (see Figure 6.) to obtain the appropriate DVM reading:
°C 0.00±0.05 mV dc [0±2 mV dc]
°F 32.0±0.1 mV dc [32.0±4 mV dc]
If necessary, additional cw range can be added to R2 by adding a solder bridge across E8 and E9 as shown in Figure 5.

f. Immerse the probe tip approximately 2 inches into a 70 to 100°C bath and allow the DVM reading to stabilize. Change DVM range, if necessary, for °F calibration.

g. Adjust R4 to obtain a DVM reading which agrees with the bath temperature (BT) as monitored by a mercury thermometer.
°C BT±0.05 mV dc [BT±2 mV dc]
°F BT±0.1 mV dc [BT±4 mV dc]

NOTE

If the unit is calibrated on the °F scale, interaction will occur between adjustments R2 and R4. Repeat steps d, e, f and g until readings are obtainable without adjustment.

Table 2. Test Equipment Requirements

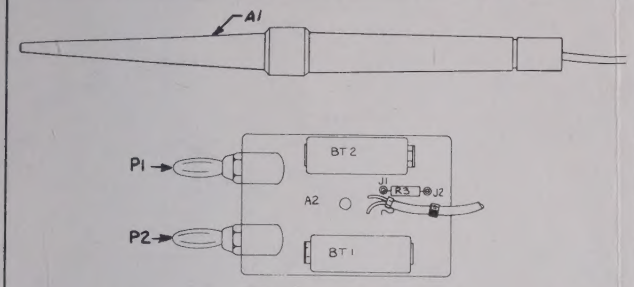
Instrument Type	Minimum Use Specifications	Recommended Model
Mercury Thermometer	0.1°C Resolution	Princo Model SAMA-CP45
Dewar Flask and Cap	1-pint capacity (for ice bath)	Thermos Bottle
Metal or Glass Container	1-pint capacity	Suitable for boiling water
Digital Volt Meter	100 mV range with 10 uV Resolution	Fluke Model 8600A
	1000 mV range with 100 uV Resolution	

PROBE REPLACEMENT

A probe kit (80T-150-7001k) is available for replacing damaged or defective probes. The kit includes a probe and cable assembly, four metal film resistors (R3), and an installation and calibration instruction sheet.

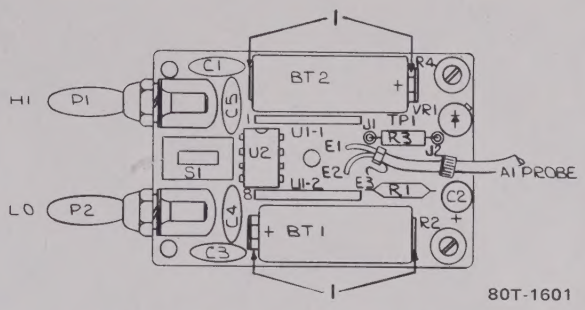
LIST OF REPLACEABLE PARTS

Component location drawings and a list of replaceable parts are shown in Figure 6. When ordering parts, provide description, Fluke pn and quantity required.



Model 80T-150 Final Assembly

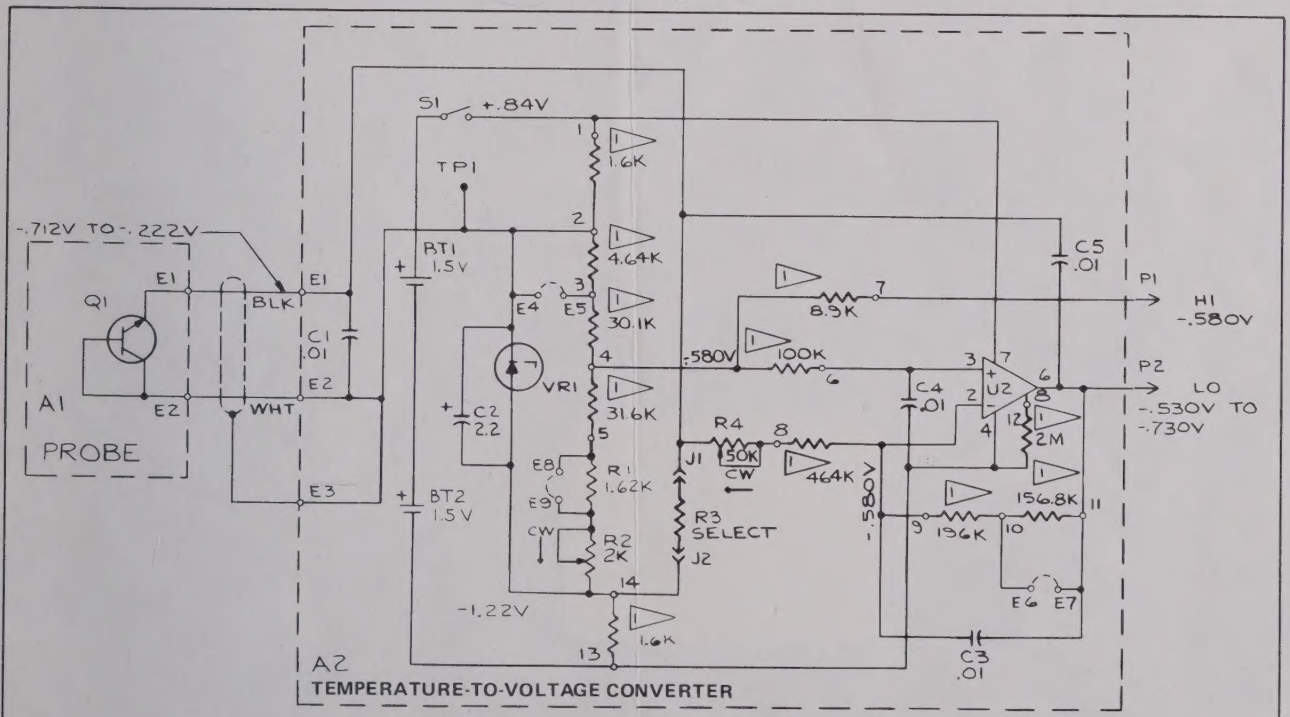
REF. DESIG.	DESCRIPTION	FLUKE P/N	TOTAL QTY.
A1	Sensing Probe and Cable Assembly, 80T-150-7001 K (includes selected resistor R3)	431023	1
A2	Temperature-to-Voltage Converter PCB Assembly (order 80T-150)		
BT1, BT2	Battery, Alkaline, 1.5V, size N	478735	2
J1,J2	Socket, 1-pin	343285	2
P1,P2	Plugs, banana	352716	2
R3	Resistor, selected (supplied with A1 Assy)		1
1	Button, switch, green (not shown)	432575	1
2	Housing, bottom (not shown)	527747	1
3	Housing, top (not shown)	527739	1
4	Shock absorbers (not shown)	428441	2
5	Decal, bottom (not shown)	534792	1
6	Decal, top (not shown)	534784	1
7	Screw (not shown)	183574	3



Temperature-to-Voltage Converter PCB Assembly

REF. DESIG.	DESCRIPTION	FLUKE P/N	TOTAL QTY.
C1, C3, C4, C5	Cap, disc, 0.01 uF ±20%, 100V dc	149153	4
C2	Cap, Ta, 2.2 uF ±20%, 20V dc	161927	1
R1	Res, metal film, 1.62k ±1%, 1/8W	282697	1
R2	Res, variable, 2k, 1/2W	226076	1
R3	See Final Assembly		
R4	Res, variable, 50k 1/2W	225417	1
S1	Switch, slide	393629	1
U1-1	Resistor Network	616615	1
U1-2	Resistor Network	616656	1
U2	IC, linear op amp	418913	1
VR1	Diode, zener, 1.22V dc	452771	1
1	Contact, Battery	477463	4

Figure 6. List of Replaceable Parts



NOTES:

1. Part of resistor network U1
2. Unless otherwise noted, all capacitance is in uF and all resistance is in ohms.
3. All voltages measured with respect to TP1.

80T-1201

Figure 7. 80T-150 Temperature Probe Schematic

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